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FINAL REPORT TO THE PAYETTE NATIONAL FOREST ON STREAM ECOLOGY RESEARCH PERFORMED DURING 1992.

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FINAL REPORT

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INTRODUCTION

A key aspect of our 1992 studies was a revisiting of several sites we had examined previously. These sites represent a core set of wilderness monitoring streams. Besides being located in the heart of the Frank Church River of No Return Wilderness, the streams are well suited to a monitoring program because they represent a range of conditions and are readily accessible from the University of Idaho's Taylor Ranch. Four of the streams were variously impacted by the Golden Fire in 1988 (Cliff, Cougar, Dunce, and Goat Creeks) and drain catchments having a predominately south-facing aspect. A more distant southern-aspet control stream (unburned), Cave Creek, will be reexamined in 1993. The other two core streams are located in north-facing catchments which sustained minor (Pioneer) to moderate burning (Rush) during the 1991 Rush Point fire. These wilderness monitoring streams enable us to examine the response (recovery) of watersheds to (from) relatively low impact fires and will help to determine the natural range of vaiability found in relatively natural stream ecosystems.

The research agenda for 1992 had four primary objectives:

1) Continue the temporal monitoring of Cliff Creek (now encompassing 5 years (1988-1992) of benthic data);

2) Analysis of temporal trends for Rush and Pioneer Creeks;

3) Continued monitoring of four streams (Cliff, Cougar, Dunce, and Goat Creeks) impacted by the 1988 Golden Fire (now encompassing three years (1990-1992) of postdire benthic data);

4) Interbasin comparison of streams ranging in size from 1st through 6th order using various abiotic (habitat) and biotic (macroinvertebrate) measures.

METHODS

General field methods used for the various segments of this study are summarized in Table 1. These are relatively routine in stream ecology and are described in detail in standard reference sources (Weber 1973, Greeson et al. 1977, Lind 1979, Merritt and Cummins 1984, APHA 1990) or in more specific references listed in Table 1. The percent charcoal of BOM was determined by spreading the dried organic matter on a white piece of paper and visually estimating the %charcoal in quarterly increments (i.e.,0, 25, 50, 75, or 100%). Additional variables were analyzed for objective 4 above, and are described in Table 2. In particular, the ratio of bankfull depth to baseflow depth (H/L) was calculated as an index of discharge flux. Since annual maximum stream temperatures consistently occur during the July sampling season, annual temperature range can be estimated from observed stream temperatures with minimum temperature equal to 0°C. Mean substratum size, water depths, and bottom velocities were determined at 100 random locations along a significant (ca. 200 meters) reach of stream. Methods for sampling macroinvertebrates are described in Platts et al. (1983). Procedures for sample analysis also are described in Table 1. Macroinvertebrates were examined in terms of density, biomass, species richness, Simpson's dominance index (C), Shannon's diversity (H'), functional feeding groups, and specific taxon changes. Locations of streams analyzed for the various objectives are summarized in Table 3.

RESULTS

Cliff Creek Temporal Study: 1988-1992

<u>Chemical and Physical Measures:</u> Stream gradient at the study reach averaged 11% (Table 4). Discharge was higher in 1990 (0.32

Table 1. SUMMARY OF VARIABLES, SAMPLING METHODS, AND ANALYTICAL PROCEDURES FOR EVALUATING THE EFFECTS OF WILDFIRE ON STREAM ECOSYSTEMS

VARIABLE	SAMPLE TYPE	SAMPLING METHOD	ANALYTICAL METHOD	REFERENCE
A. Physical				
1. Temperature (°C)	P	Maximum-Minimum recording thermometers.	Direct Observation	
2. Discharge (m^3/s)	T	Velocity-depth profiles.	Calculation: Q=W•D•V; where W=width, D=mean depth, and V=velocity.	Bovee and Milhous 1978
Width (0.1m)	P	Nylon-reinforced meter tape.	Determine width of water and bankful width.	Buchanan and Somers 1969
Depth (0.1m)	T	Meter stick.	Determine water and bankful depths at sufficient intervals to give a good estimate of the mean. No more than 10% of flow should pass between measurements.	
Velocity (0.1m/s)	T	Small Ott C-1 current meter.	Determine velocities at 0.6 x depth (from the surface) at sufficient intervals to give a good estimate of the mean. No more than 10% of the flow should pass between measurements. Estimate bankful velocities from Manning's equation.	Gregory and Walling 1973
3. Channel Gradient (%)	P	Inclinometer.	Measure water surface elevations over extended (150m) lengths upstream and downstream of the discharge transect.	
4. Substrate Particle Size	R	Select 100 rocks at random, measure L, W, and D axes.	Calculate mean volume , median diameter, CV's, distributions	Leopold 1970
5. Embeddedness	R	Ocular, adjacent to previously mentioned 100 rocks.	Optical determination of degree of embeddeness by silt and sand	Platts et al. 1983
B. Chemical	P	"Grab" samples from center of stream.		
1. Alkalinity (mg/l)			Gran (in waters <40mg/l alkalinity) or methyl orange titration.	Talling 1973 APHA 1989
2. Hardness (mg/l)			EDTA titration.	APHA 1989
3. Specific Conductance (µmhos)		Determine in the field.	Temperature compensated portable YSI meter. Estimate total dissolved solids using standard conversion factor.	APHA 1989
C. Biological				
1. Periphyton	P/R	Collect samples from five separate cobblestones. Remove material from known area. Brush and rinse three times following prescribed technique. Collect material from each rock on a separate pre-combusted, tared, glass-fiber filter (Whatman GFF).	Acetone extraction of chlorophyll followed by spectro-photometric assay with correction for phaeopigments. Recombine acetone with sample and evaporate to dryness. Determine AFDM as described below.	Stockner and Armstrong 1971 Lorenzen 1966
2. Benthic invertebrates	P/R	Surber sampler fitted with 250 µm mesh net. Collect 5 samples per site in proportion to principal habitat types. Disturb substratum to depth of 10cm, remove all organic matter from larger inorganic particles, preserve in 5% formalin.	Separate invertebrates by species, count, dry at 60°C, and weigh. Determine population densities and biomass, species richness, dominance, diversity, and functional feeding group composition.	Platts et al. 1983 Merritt and Cummins 1984
3. Benthic organic matter	P/R	Recover from Surber samples described above.	Estimate percent composition of various plant components (including charcoal) dry at 60°C, ash at 550°C, determine total AFDM.	

P = point sample
R = random throughout a defined lineal reach
T = transect across stream

Table 2. Characteristics measured, scale of influence, sample type and sample size used in analyses.

CATEGORY	MEASURED CHARACTERISTIC	REPRESENTATIVE SCALE	SAMPLE TYPE	SAMPLE SIZE
Geomorphic Descriptors	Order	Among/Spatial	Point	1
	Link	Among/Spatial	Point	1
	Discharge	Among/Spatial	Transect	1
	Width	Among/Spatial	Transect	5
	Highflow Depth	Among/Spatial	Transect	variable
	Lowflow Depth	Among/Spatial	Random	100
	CV-Lowflow Depth	Within/Spatial	Random	100
	Slope	Among/Spatial	Point	5
	Elevation	Among/Spatial	Point	1
Chemical	pH	Among/Spatial	Point/Grab	1
	Conductivity	Among/Spatial	Point/Grab	1
	Hardness	Among/Spatial	Point/Grab	1
	Alkalinity	Among/Spatial	Point/Grab	1
Physical	Temperature (Delta-T)	Among/Temporal	Point	2
	Bottom Velocity	Among/Spatial	Random	100
	CV-Bottom Velocity	Within/Spatial	Random	100
	Substrate	Among/Spatial	Random	100
	CV-Substrate	Within/Spatial	Random	100
	Highflow/Lowflow (Delta-Q)	Among/Temporal	Transect	5
Food Resources	Chlorophyll a	Among/Spatial	Random	10/5*
	CV-Chlorophyll a	Within/Spatial	Random	10/5*
	Algal AFDM	Among/Spatial	Random	10/5*
	CV-Algal AFDM	Within/Spatial	Random	10/5*
	Autotrophic Index	Among/Spatial	Random	10/5*
	Benthic Organic Matter	Among/Spatial	Random	10/5*
	CV-BOM	Within/Spatial	Random	10/5*
Macroinvertebrates	Density	Among/Spatial	Random	10/5*
	Biomass	Among/Spatial	Random	10/5*
	Species Richness	Among/Spatial	Random	10/5*
	Diversity	Among/Spatial	Random	10/5*
	Functional Group	Among/Spatial	Random	10/5*

*Note=Sample size equals 10 for 1988 collection only.

Table 3. Locations of study sites used to meet research objectives.

STREAM	YEAR SAMPLED	OBJECTIVE MET	DRAINAGE BASIN	ORDER	SLOPE	ELEVATION	COORDINATES
CLIFF	1988-1992	1	BIG	2	13.0	1196	114'51";45'07"
RUSH	1988,'91,'92	2	BIG	5	1.0	1171	114'51";45'07"
PIONEER	1990-1991	2	BIG	3	3.0	1165	114'51";45'06"
CLIFF	1990-1992	3	BIG	2	13.0	1196	114'51";45'07"
COUGAR	1990-1992	3	BIG	3	12.0	1095	114'49";45'07"
DUNCE	1990-1992	3	BIG	2	15.0	1065	114'47";45'07"
GOAT	1990-1992	3	BIG	2	18.0	1125	114'48";45'07"
BEAVER	1988	4	BIG	3	4.0	1537	115'14";45'10"
BIG at COXEY	1988	4	BIG	6	1.5	1305	115'02";45'08"
BIG at GORGE	1988	4	BIG	6	1.0	1122	114'47";45'07"
BIG at RUSH	1988	4	BIG	6	1.5	1174	114'51";45'07"
CLIFF	1988	4	BIG	2	13.0	1196	114'51";45'07"
RAMEY	1988	4	BIG	4	3.5	1440	115'10";45'11"
RUSH	1988	4	BIG	5	1.0	1171	114'51";45'07"
PIONEER	1990	4	BIG	3	3.0	1165	114'51";45'06"
DOE	1990	4	BIG	3	16.0	1260	114'58";45'08"
DUNCE	1990	4	BIG	2	15.0	1065	114'47";45'07"
GOAT	1990	4	BIG	2	18.0	1125	114'48";45'07"
MTHCAVE	1990	4	BIG	3	6.0	1220	114'57";45'08"
COUGAR	1990	4	BIG	3	12.0	1095	114'49";45'07"
PIONEER UP	1990	4	BIG	2	6.0	1485	114'51";45'05"
WFCAVE	1990	4	BIG	3	6.0	1365	114'58";45'11"
SLIVER	1991	4	BIG	2	5.0	1880	115'04";45'13"
PACKHOR	1991	4	BIG	2	4.0	1780	115'02";45'12"
CROOKED	1991	4	BIG	3	3.0	1780	115'02";45'18"
McCALL E	1991	4	CHAMBERLAIN	2	2.0	1915	115'08";45'17"
McCALL 3	1991	4	CHAMBERLAIN	3	2.0	1890	115'08";45'17"
McCALL 4	1991	4	CHAMBERLAIN	4	2.0	1820	115'06";45'18"
WHIM MAIN	1991	4	CHAMBERLAIN	4	1.0	1710	115'01";45'17"
WHIM SF	1991	4	CHAMBERLAIN	3	2.0	1730	115'01";45'17"
WHIM EF	1991	4	CHAMBERLAIN	2	2.0	1745	115'01";45'18"
CHAMBERLAIN	1992	4	CHAMBERLAIN	6	3.5	1032	114'58";45'25"
WF CHAMBERLAIN	1992	4	CHAMBERLAIN	3	1.5	1806	115'11";45'24"
PHANTOM	1992	4	CHAMBERLAIN	1	18.0	1871	114'51";45'23"
PISTOL	1992	4	MF SALMON	5	1.8	1548	115'10";44'43"
INDIAN	1992	4	MF SALMON	5	1.5	1450	115'06";44'46"
LOON	1992	4	MF SALMON	6	1.0	1291	114'47";44'48"
RAPID	1992	4	MF SALMON	6	2.5	1613	115'10";44'40"
MFSALMON	1992	4	MF SALMON	6	1.0	1613	115'10";44'40"
CAMAS	1992	4	MF SALMON	5	1.0	1226	114'44";44'53"

NOTE: Streams of MF Salmon basin used for analysis of large streams >5th order.

m^3/s) and 1991 (0.18 m^3/s) than in 1988 (0.04 m^3/s) perhaps reflecting greater groundwater inputs following the fires in 1989. Discharge was low in 1992 (0.08 m^3s) suggesting some vegetative recovery, and thus transpirational uptake, in upper Cliff Creek compounded by drought conditions. Annual Delta-T remained at 13°C in 1992, as in the previous two years, although Delta-T was only 10°C in 1988. Mean water depth reflected patterns in discharge with greater depths occuring in years of greater flows. Substratum size remained unchanged, averaging 25 cm.

Little change has occured in water chemistry in Cliff Creek during the study period. For example, hardness values ranged from 49 to 71 (mg/L $CaCO_3$)(Table 4). However, specific conductance has increased over time, from 61 umhos/cm) in 1988 and 1990 to 99 (umhos/cm) in 1992. Stream pH has remained at ca. 8 among study years. Nutrient analyses, monitored by Taylor Ranch, showed low levels of phosphorus and ammonium (NH_4) in Cliff Creek, but much elevated values for nitrate (NO_3) relative to other sites monitored (Fig. 1). Higher values in Cliff Creek relative to Rush and Pioneer Creeks may reflect aspect differences and the much greater terrestrial vegetative growth in the Pioneer and Rush catchments in addition to fire effects.

<u>Periphytic and Benthic Organic Matter:</u> Algal chlorophyll levels were highest in 1991 and were similar in 1988, 1990, and 1992 (Fig. 2). Algal AFDM was lowest in 1992 over the previous years of study. Biomass:Chlorophyll ratios have decreased to ca. 200 since the high of 800 in 1988.

Benthic organic matter was highest in 1988, averaging 100 g/m^2 (Fig. 3). BOM values were lower from 1989 through 1992, with lowest values observed in 1992. The % charcoal of BOM has steadily increased following 1988, with the highest percentage found in 1992 (ca. 30%), suggesting that BOM is being washed into

Table 4. Physical and chemical data for Cliff Creek in 1988, 1990, 1991, and 1992.

Parameter	1988		1990		1991		1992	
	Mean	CV	Mean	CV	Mean	CV	Mean	CV
SLOPE (%)	13		10		11		9	
ELEVATION (m)	1145		1145		1145		1145	
DISCHARGE (m^3/s)	0.04		0.32		0.18		0.08	
ANNUAL TEMP RANGE	10.0		13.0		13.0		13.0	
WIDTH, HIGHFLOW (m)	4.8		3.5		3.8		5.5	
DEPTH, HIGHFLOW (m)	0.7	0.5	0.5	0.3	0.5	0.2	0.4	0.4
DEPTH, BASEFLOW (m)	0.1	0.9	0.2	0.2	0.2	0.4	0.2	0.7
DEPTH, (H-L)	0.6		0.3		0.3		0.3	
WIDTH:DEPTH RATIO	60.0		18.6		22.5		34.4	
DEPTH(H/L)	9.0		2.5		2.9		2.6	
SUBSTRATE LENGTH (cm)	16.2	0.63	25.3	0.74	22.5	0.85	26.7	1.03
ALKALINITY (mg/l CaCO3)	35.0		35.0		77.0		48.0	
HARDNESS (mg/l CaCO3)	66.0		66.0		71.0		49.0	
pH	8.2		8.2		8.2		8.0	
SPECIFIC CONDUCTANCE (umhos/cm @25 C)	61.0		61.0		73.0		99.0	
CHLOROPHYLL (mg/m2)	2.4	8.8	2.0	13.5	8.8	1.4	1.2	3.4
CHL. AFDM (g/m2)	1.9	1.0	0.9	0.5	1.8	0.6	0.3	0.2
B/C (AFDM/CHLOROPHYLL)	804		450		205		242	
BOM (g/m2)	98.4	1.2	41.5	0.9	25.6	0.4	11.7	0.5

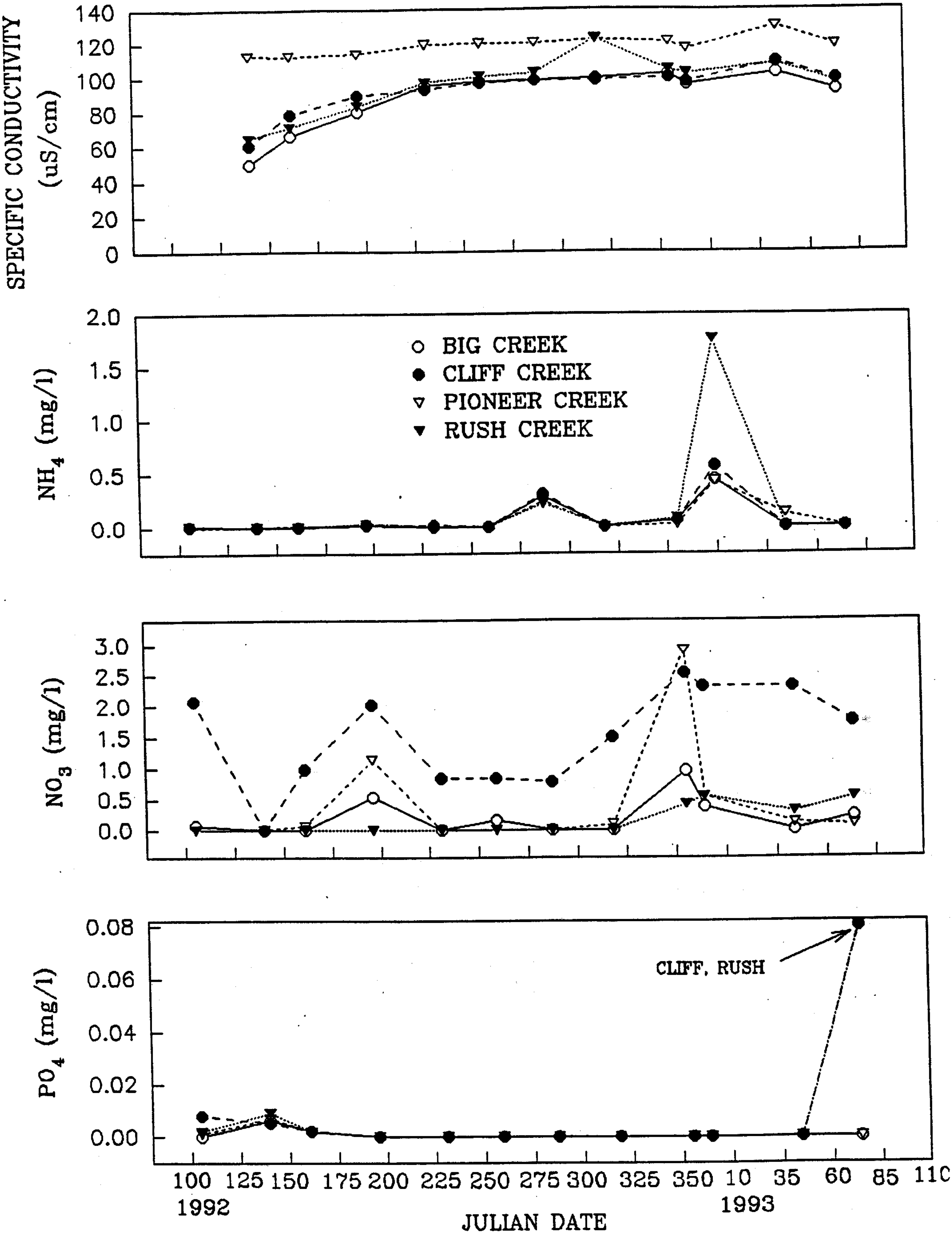

Figure 1 . Chemical data for Big, Cliff, Pioneer, and Rush Creeks from 4/14/92 through 3/15/93.

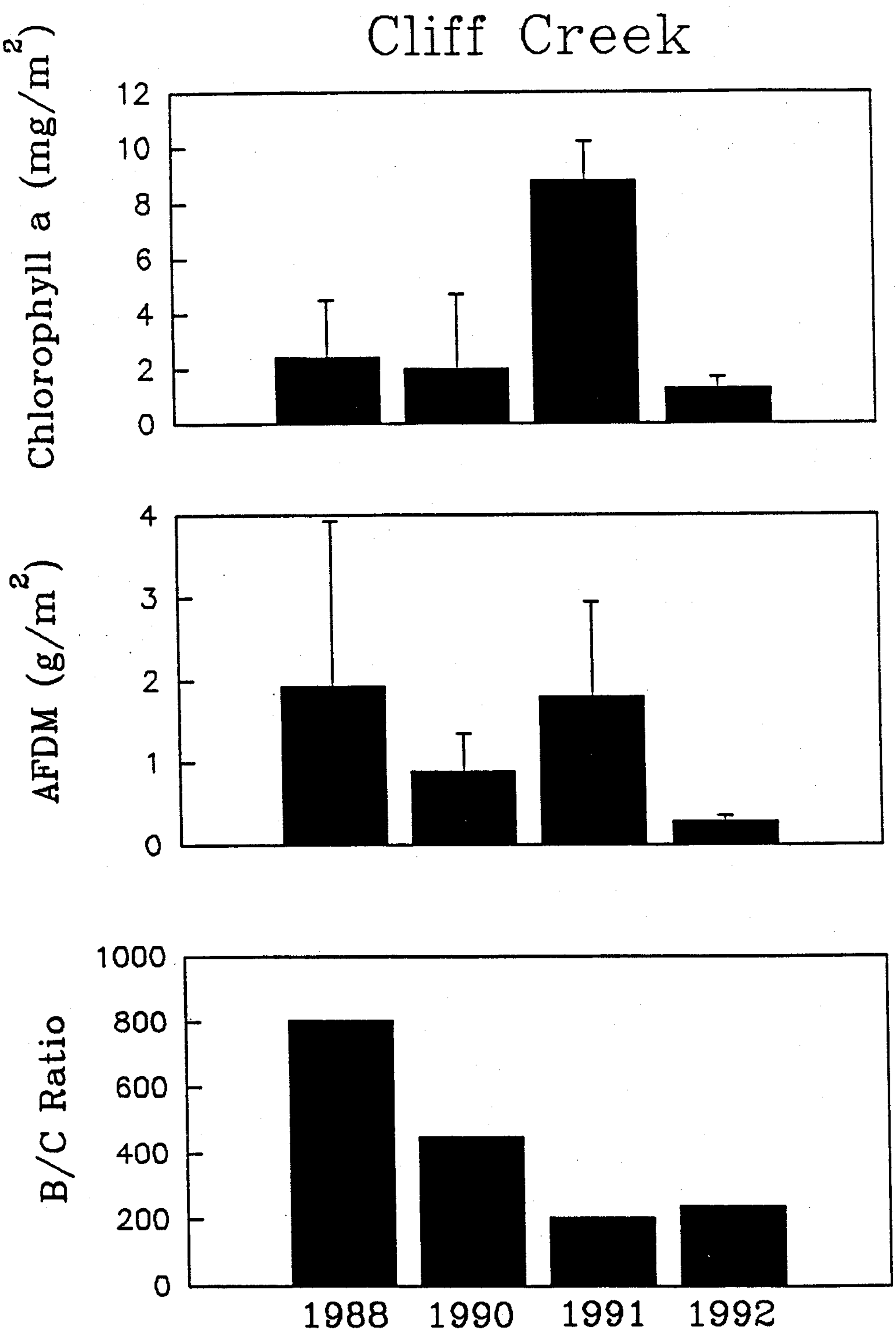

Figure. 2. Periphyton chlorophyll–a, Ash–Free– , Dry–Mass, and Biomass/Chlorophyll (B/C) ratio for Cliff Creek from 1988 through 1992. Error bars equal one standard deviation from the mean (n=10, 1988; n=5, all other dates).

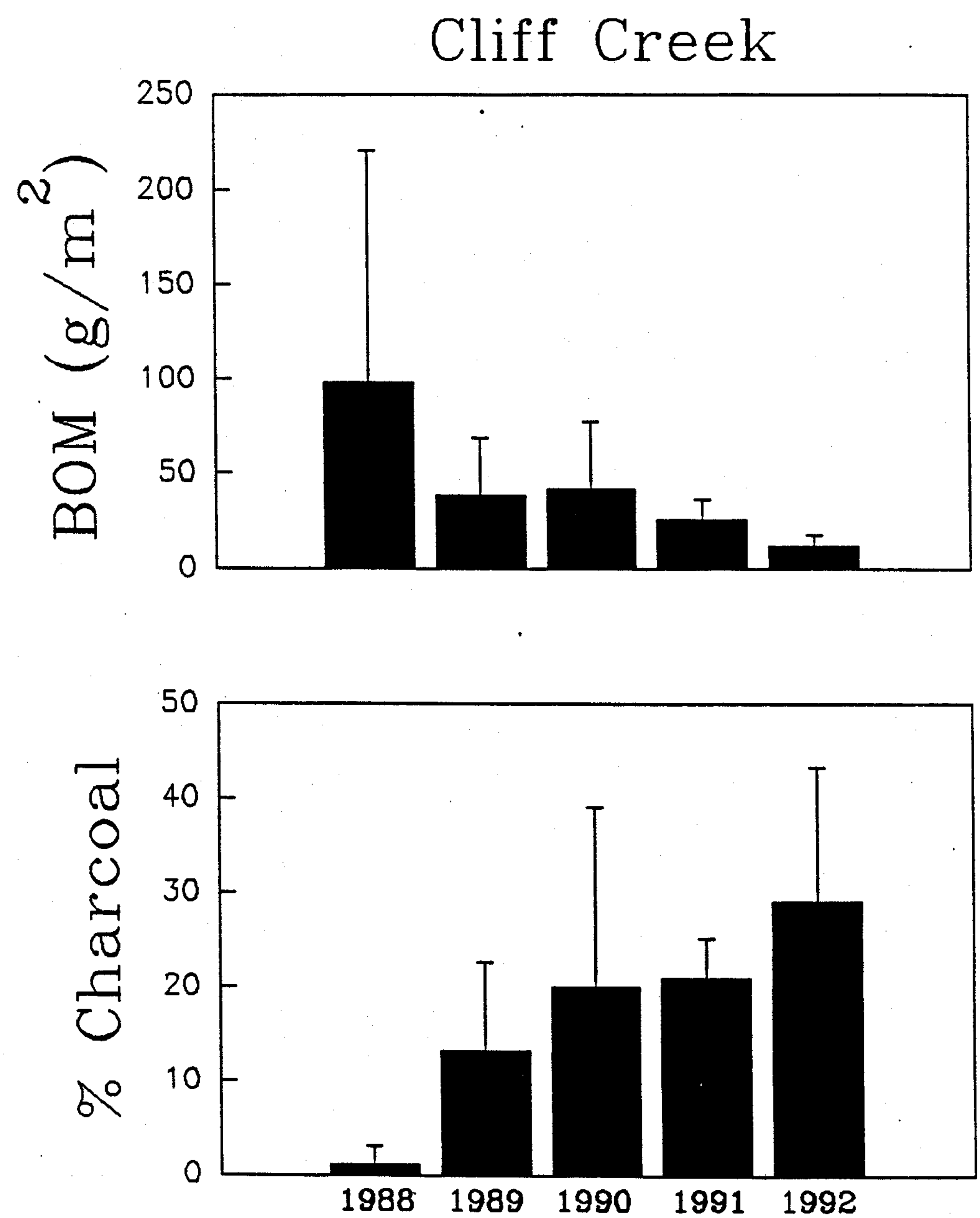

FIgure. 3. Benthic organic matter (BOM) and percent charcoal of BOM for Cliff Creek in 1988, 1989, 1990, 1991, and 1992. Error bars equal one standard deviation from the mean (n=5, 1988; n=10, all other dates).

the study reach from upstream.

<u>Benthic Macroinvertebrates:</u> Total density and species richness increased in 1992 from 1991 (Fig.4). In contrast, Shannon's diversity (H') remained unchanged from 1991 values in 1992, with both year's values being lower than found previously in 1988-1990 (Fig. 5). Simpson's dominance also remained unchanged from 1991 values in 1992, with both year's being higher than those observed in 1988-1990. Overall, density has varied widely among years (although not statistically significant), biomass had shown a gradual decline, and species richness had remained relatively constant (except for 1991).

Little change occured in the relative abundances of functional feeding groups based on density (Table 5). As in 1991, miners were predominant in 1992, representing 54% of the assemblage. Scrapers (25%) and Gatherers (11%) also were predominant in 1992 in Cliff Creek. These three groups have been predominant since the study began in 1988.

In terms of biomass, shredders were abundant in 1988 and 1989 and then decreased in 1990-1992 (Table 5). Filterers were predominant, by weight, in 1989 at 41%. The predominance of miners was reduced substantially when using biomass data in 1988 through 1990, but markedly increased in 1991 and 1992. Gatherers and scrapers were abundant for all study years in terms of both numbers and biomass.

Oligochaeta was the predominant taxon in 1988 in Cliff Creek, then decreased in 1989 and 1990, and again was predominant in 1991 and 1992 (Table 6). *Baetis* increased in abundance in 1989 and 1990, decreased in 1991, and again increased in 1992. *Heterlimnius* and Chironomidae also were abundant during the four years of study.

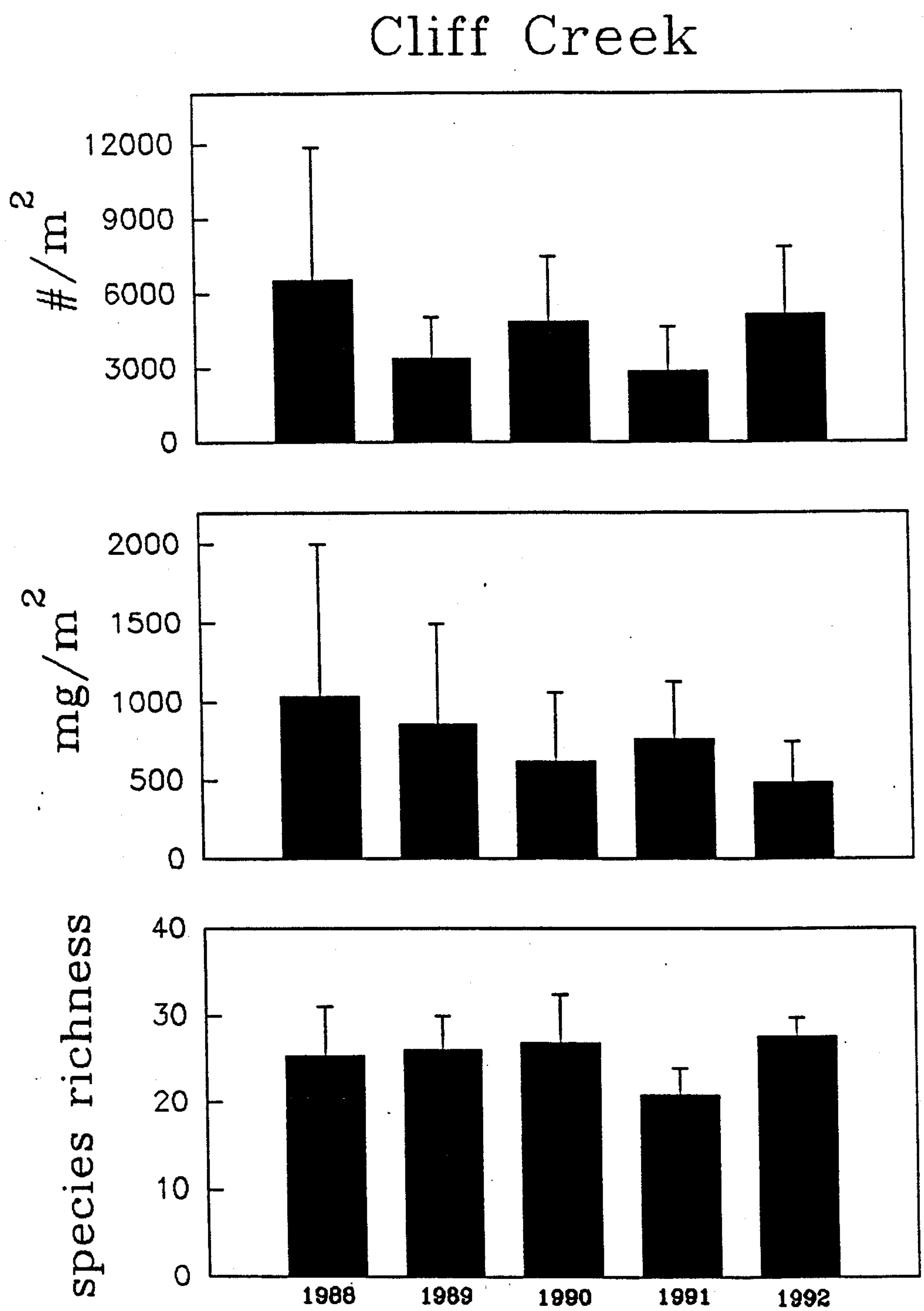

Figure 4. Mean density, biomass, and species richness of macroinvertebrates collected at Cliff Creek in 1988 through 1992. Error bars represent one standard deviation from the mean (n=10, 1988;. n=5, all other dates).

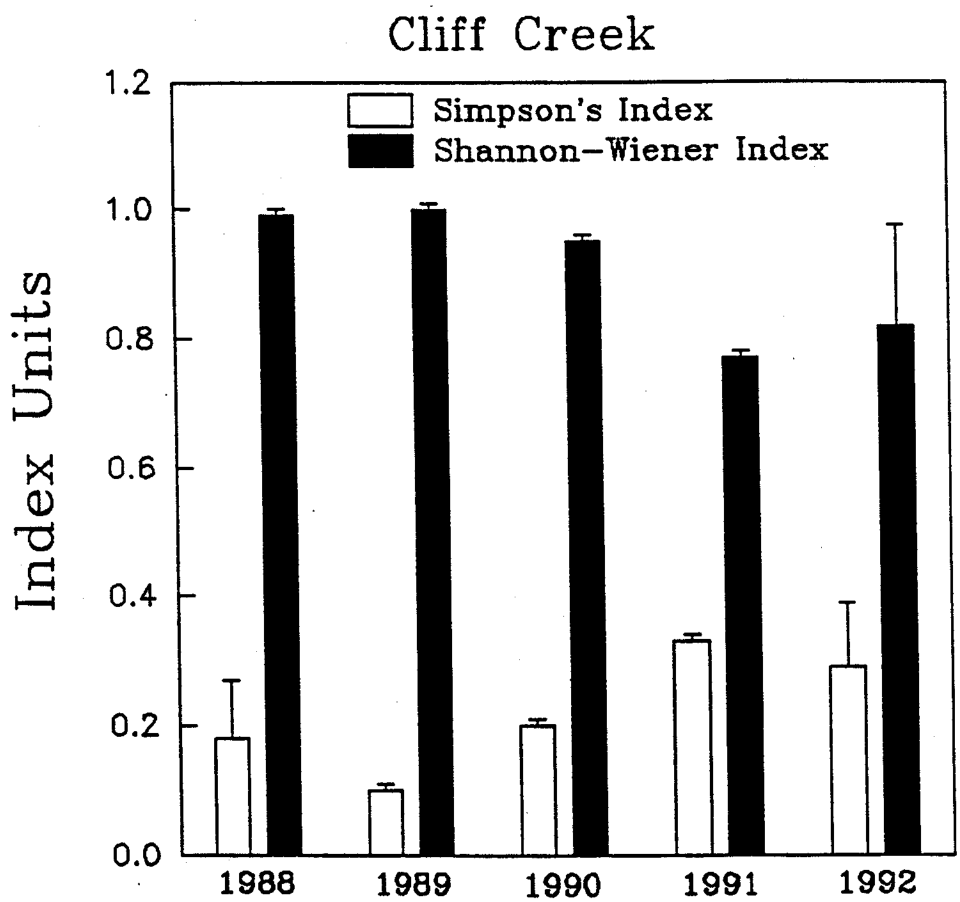

Figure 5. Mean values for 1) Simpson's Dominance (S) and Shannon–Weiner Diversity (H') for macroinvertebrates collected at Cliff Creek in 1988 through 1992. Error bars equal one standard deviation from the mean(n=10, 1988; n=5, all other dates).

Table 5. Mean and relative abundances (#/m2) and biomass (mg/m2) of macroinvertebrate functional feeding groups collected at Cliff Creek in 1988 through 1992.

FFG	1988		1989		1990		1991		1992	
	mean	rel %	mean	rel %	mean	rel %	mean	rel %	mean	rel %
ABUNDANCE										
Predator	537.8	8.2	435.3	12.9	667.9	14.1	224.1	12.7	148.4	3.2
Gatherer	1150.2	17.6	512.2	15.1	761.8	14.5	275.3	15.8	630.1	10.77
Scraper	1267.6	19.4	1228.1	36.3	1195.1	29.1	384.1	21.7	412.9	25.1
Shredder	503.6	7.7	161.1	4.8	138.7	2.4	46.9	2.7	215.1	3.3
Filterer	559.1	8.6	303.0	9.0	337.2	8.3	100.3	5.7	131.2	2.8
Miner	2497.7	38.2	745.8	22.0	1720.0	30.5	736.2	41.7	2754.7	54.9
BIOMASS										
Predator	63.1	6.1	4.5	10.6	88.7	15.1	83.2	12.7	31.9	6.7
Gatherer	190.0	18.4	3.7	8.7	162.8	24.2	102.4	15.6	62.7	13.0
Scraper	230.5	22.3	5.4	12.7	182.5	28.3	142.9	21.8	230.8	47.7
Shredder	205.6	19.9	9.6	22.6	10.4	1.9	17.1	2.6	5.4	1.1
Filterer	18.9	1.8	17.3	40.8	111.9	14.8	37.3	5.7	81.2	16.8
Miner	126.9	12.3	1.9	4.5	58.3	8.8	273.2	41.6	67.5	14.0

Table 6. Densities (#/m2) and relative percentages of the ten most abundant invertebrate taxa collected at Cliff Creek in 1988 through 1992.

TAXA	JULY 1988			JULY 1989			JULY 1990			JULY 1991			JULY 1992		
	MEAN	STD	REL %	MEAN	STD	REL %	MEAN	STD	REL %	MEAN	STD	REL %	MEAN	STD	REL %
Baetis sp.	312.6	457.4	4.8	334.8	269.3	9.9	864.2	1030.0	17.8	224.1	148.5	7.9	849.4	337.2	16.5
Chironomidae	353.2	476.6	5.4	448.1	385.1	13.2	1000.8	1383.4	20.6	138.0	52.5	4.8	161.3	91.9	3.1
Cinygmula spp.	617.8	334.9	9.4	229.4	104.5	6.8	202.7	249.3	4.2	85.4	78.0	3.0			
Doliphilodes													333.3	576.6	6.5
Drunella doddsi										32.0	17.5	1.2	217.7	159.7	4.2
Ephemerella infrequens				144.0	109.9	4.3									
Epeorus deceptious													118.3	107.5	2.3
Glossosoma spp.				328.1	291.9	9.7									
Heterlimnius spp.	387.3	410.7	5.9	409.5	282.0	12.1	672.2	369.7	13.8	224.1	160.4	7.7	376.3	213.6	7.3
Nematoda	275.3	833.2	4.2												
Neophylax													118.3	96.8	2.3
Oligochaeta	2116.9	2619.3	32.1	290.8	292.0	8.6	706.4	796.3	14.5	1707.2	1327.0	59.4	2593.4	1345.1	50.4
Ostracoda	273.2	863.8	4.2	189.4	102.5	5.6	151.5	46.1	3.1						
Polycentropus spp.	434.3	1347.1	6.6												
Serratella tibialis										32.0	40.9	1.0			
Simulium spp.	284.9	77.2	4.4				155.8	194.7	3.2	85.4	45.7	3.1	143.4	78.7	2.8
Suwallia spp.	345.7	351.5	5.3	264.1	157.8	7.8	326.5	350.1	6.7	96.0	79.2	3.4			
Zapada sp.				132	179.7	3.9				32.0	15.1	0.9	344.1	389.8	6.7

Rush Creek and Pioneer Creek Comparative Study

Physical and Chemical Measures: Rush Creek is a 5th order stream combining 223 links, whereas adjacent Pioneer Creek is a 3rd order stream comprised of only 18 links (Table 7). The larger size of Rush Creek is observed in greater stream widths (about 5X greater mean width in Rush than Pioneer) and discharge (ca. 10X greater Q in Rush than Pioneer). Stream gradient at the study sites are 1 and 3%, respectively. Both sites are located at about 1170 m in elevation.

Maximum and minimum water temperatures were recorded from October 1991 through late May 1992 (Fig. 6). Temperatures in Pioneer Creek displayed a range from 0°C to 12°C, whereas the larger Rush Creek showed maximum temperatures of 17°C with the same minimum. Rush Creek also displayed greater among year variation (Delta-T 14-18°C) than Pioneer Creek (Table 7). Pioneer Creek displayed higher values for specific conductance than Rush Creek for most sampling periods (Fig. 1, Table 7). Both sites showed low values for phosphorus, ammonium and nitrates in data obtained by Taylor Ranch personnel (Fig. 1).

Average velocities near the stream bottom decreased in Rush Creek in 1992 from values observed in 1988, probably resulting from the lower discharge in 1992 (Table 7). Both sites exhibited similar high-depth/low-depth ratios suggesting similar temporal heterogeneity due to flow. In addition, baseflow water depth, substrate size, and percent embeddedness was similar in both sites.

Periphytic and Benthic Organic Matter:

Algal chlorophyll *a* and AFDM levels were greater in Rush than in Pioneer Creek, most likely resulting from the more open canopy and hence higher temperature and light conditions at the Rush

Table 7. Physical and chemical data for Rush and Pioneer Creeks. Means are based on n=5, except for vel and sub where n=100.

	RUSH			PIONEER	
	1988	1991	1992	1990	1991
ORDER	5	5	5	3	3
LINK	223	223	223	18	18
SLOPE	1	1	1	3	3
ELEV	1171	1171	1171	1165	1165
TEMP	16.7	14.0	18.0	11.2	11.0
WIDTH (m)	15.1		12.0	3.4	2.0
Q (m3/s)	1.61		1.10	0.16	0.01
VELOCITY					
MEAN (m/s)	0.49		0.11	0.33	
VEL CV	0.43		0.59	0.84	
DEPTH					
hiz-loz	0.85		0.27	0.40	
hi-z	1.20		0.48	0.56	
hi-z-cv	0.15		0.42	0.22	
lo-z	0.35		0.21	0.16	
lo-z-cv	0.28		0.51	0.28	
hz/lz	3.4		3.0	3.6	
SUBSTRATE					
LENGTH (cm)	14.6		13.3	16.7	
CV	0.96		0.69	0.84	
EMBEDEDNESS (%)			18.8	12.5	
CV			1.42	1.91	
CHEMICAL					
ALKALINITY (mg/l CaCO3	36		46	62	
HARDNESS (mg/l CaCO3)	30		46	86	
pH	7.8	8.2	8.4	8.1	8
CONDUCTIVITY (uS)	110	103	95	88	125
PERIPHYTON					
CHL-a (mg/m2)	6.5	10.7	39.8	2.8	2.3
CHL-a CV	0.71		0.78	0.99	
AFDM (g/m2)	2.49	6.94	1.58	1.12	1.11
AFDM CV	0.48		0.41	0.26	
B/C RATIO	3.83	6.49	3.92	4.00	
BOM (g/m2)	18.41		12.18	7.40	
BOM CV	1.45		0.45	0.45	

NOTE: CV = Coefficient of variation.

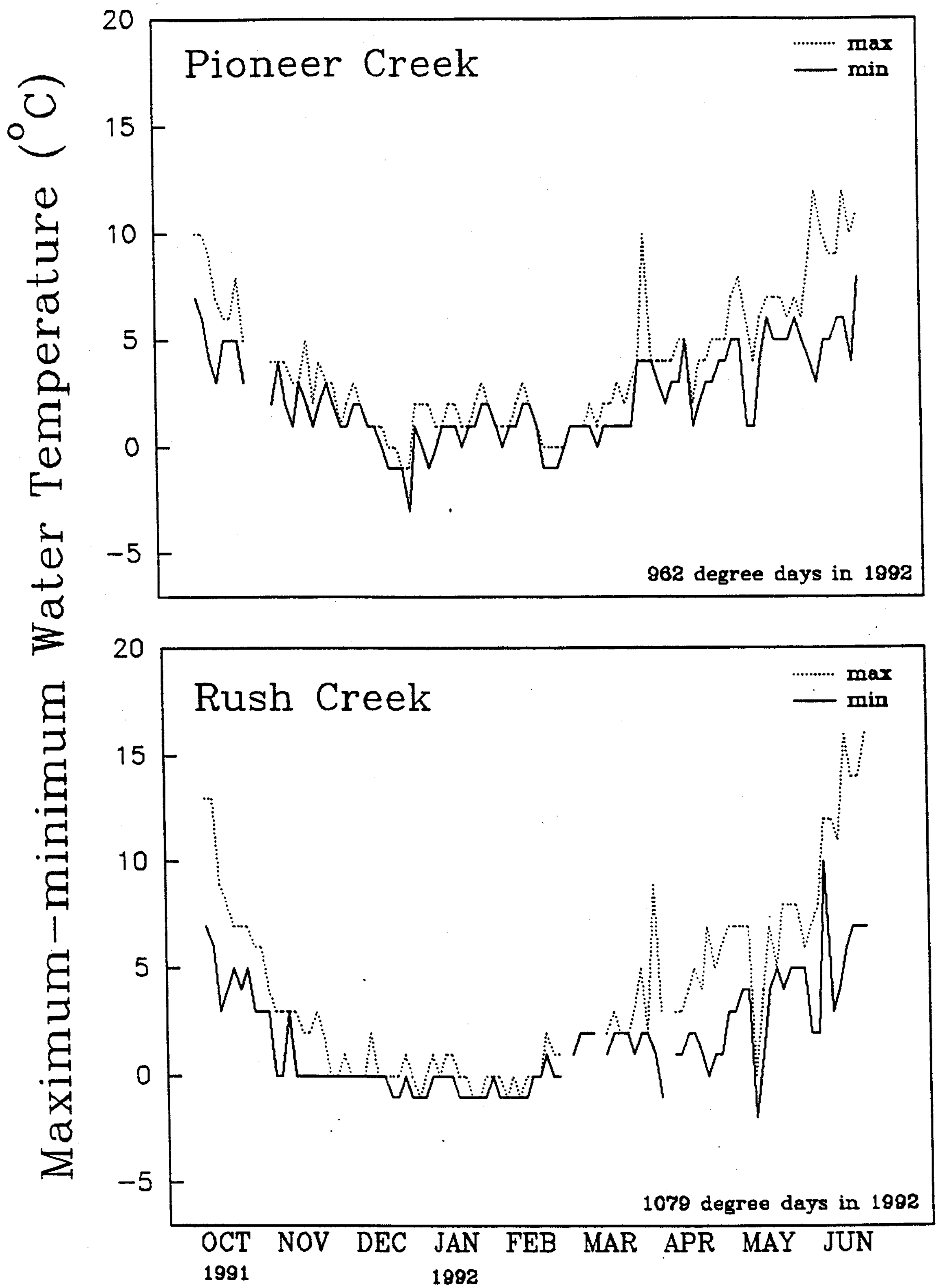

Figure 6. Maximum and minimum water temperatures for Pioneer and Rush Creeks between October 1991 and June 1992.

Creek site (Table 7). Pioneer Creek exhibited greater levels, ca. 1.5 to 2.5X) of benthic organic matter (BOM) than Pioneer Creek. In Rush Creek, chlorophyll a was much higher and periphyton AFDM and BOM were lower in 1992 compared to 1988. In Pioneer Creek, algal chlorophyll a and AFDM were similar between 1990 and 1991. The changes in Rush Creek in 1992 may have been the result of the Rush Point fire in the upper part of the watershed the previous summer.

Benthic Macroinvertebrates: Both streams exhibited increases in macroinvertebrate densities in 1991 relative to previous collection periods (Fig. 7). Rush Creek showed similar mean species richness values among years, while mean richness in Pioneer Creek increased by about 10 taxa. Dominance values substantially decreased in 1991 in Rush Creek from 1988 values suggesting a greater diversity and evenness among taxa; whereas Simpson's index and H' was unchanged in Pioneer Creek from 1990 to 1991.

1988 Golden Fire Stream-Monitoring: 1990-1992

Physical and Chemical Measures: Discharge decreased in all burn sites in 1992 from 1991 values (Table 8). Stream width and mean water depth remained similar among years (1990-1992) for each site. Average substrate size decreased by about half in Cougar and Dunce Creeks suggesting some input of fine sediments from the surrounding landscape. Little channel change was evident for any site as reflected in similar width:depth ratios among years.

Water pH was around 8.0 for all sites among years (Table 8). Specific conductance was greater in Dunce and Goat Creeks than in Cliff and Cougar Creeks suggesting some geologic changes between the basins (Dunce and Goat are located farther downstream along Big Creek than Cliff and Cougar Creeks). All sites experienced

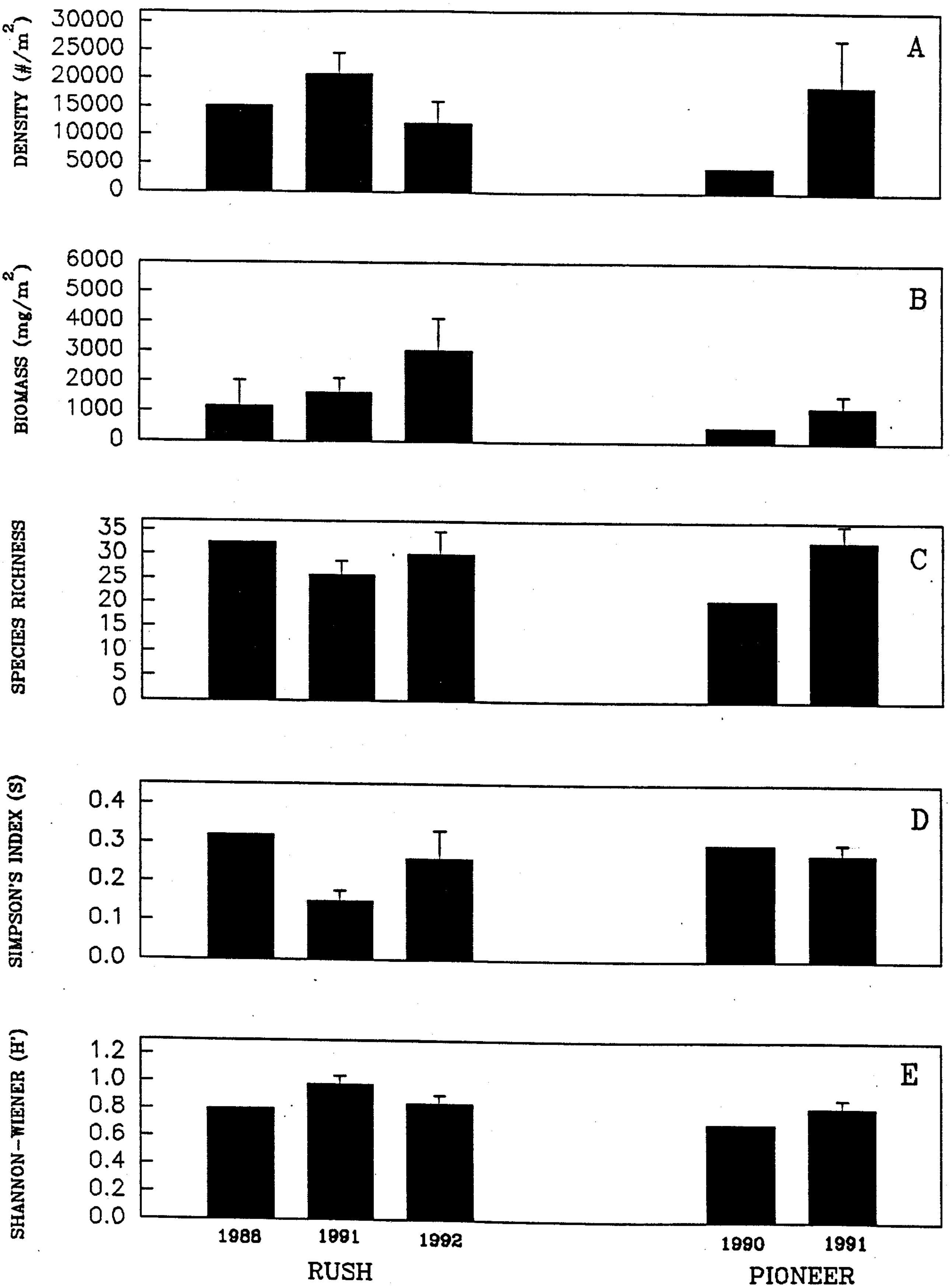

Figure 7. Macroinvertebrate density (A), biomass (B), species richness (C), Simpson's Index (D), and Shannon-Wiener Index (E) for Rush and Pioneer Creeks. Error bars equal one standard deviation from the mean (n=10, 1988; n=5, all other dates).

Table 8. Physical and chemical data for Cliff Creek, Cougar Creek, Dunce Creek, and Goat Creek in 1990, 1991, and 1992.

STREAM	CLIFF 1990 Mean	CLIFF 1990 CV	CLIFF 1991 Mean	CLIFF 1991 CV	CLIFF 1992 Mean	CLIFF 1992 CV	COUGAR 1990 Mean	COUGAR 1990 CV	COUGAR 1991 Mean	COUGAR 1991 CV	COUGAR 1992 Mean	COUGAR 1992 CV
SLOPE (%)	10		11		9		12		12		13	
DISCHARGE (m^3/s)	0.32		0.18		0.08		0.11		0.1		0.06	
WIDTH, HIGHFLOW (m)	3.5		3.8		5.5		2.7		3.1		2.6	
DEPTH, HIGHFLOW (m)	0.5	0.3	0.5	0.2	0.4	0.4	0.5	0.4	0.5	0.1	0.3	0.4
DEPTH, BASEFLOW (m)	0.2	0.2	0.2	0.4	0.2	0.7	0.2	0.0	0.2	0.3	0.2	1.1
DEPTH, (H-L)	0.3		0.3		0.3		0.3		0.3		0.2	
DEPTH, (H/L)	2.5		2.9		2.6		2.8		2.4		2	
WIDTH/DEPTH RATIO	19.0		22.5		34.4		15.4		16.2		16.4	
SUBSTRATE LENGTH (cm)	25.3	0.7	22.5	0.9	26.8	1.0	21.6	0.6	22.6	1.2	13	1.1
ALKALINITY (mg/l CaCO3)	35		77		48.0		46		36		59	
HARDNESS (mg/l CaCO3)	66		71		49.0		71		32		60	
pH	8.2		8.2		8.0		8.5		7.4		8.2	
SPECIFIC CONDUCTANCE (umhos/cm @25 C)	61		73		99.0		70		93		113	
ANNUAL TEMP RANGE (C)	13		13		13.0		11		12		13	
CHLOROPHYLL (mg/m2)	2.0	1.4	8.8	0.1	1.2	0.3	0.7	0.6	1.1	1.1	1.8	0.9
CHL. AFDM (g/m2)	0.9	0.5	1.8	0.6	0.3	0.2	0.7	0.6	0.8	0.3	0.3	0.4
B/C (AFDM/CHLOROPHYLL)	450		205		242		102		764		163	
BOM (g/m2)	41.5	0.87	25.6	0.41	11.7	0.5	57.1	1.15	25.9	0.8	20.1	0.8

Table 8 (con't)

STREAM	DUNCE 1990		DUNCE 1991		DUNCE 1992		GOAT 1990		GOAT 1991		GOAT 1992	
	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
SLOPE (%)	15		15		15		18		18		18	
DISCHARGE (m^3/s)	0.02		0.15		0.01		0.01		0.09		0.01	
WIDTH, HIGHFLOW (m)	1.1		1.1		1.2		0.9		0.9		0.8	
DEPTH, HIGHFLOW (m)	0.2	0.3	0.2	0.2	0.3	0.5	0.2	0.4	0.2	0.3	0.2	0.5
DEPTH, BASEFLOW (m)	0.1	0.3	0.1	0.2	0.1	0.7	0.1	0.2	0.1	0.3	0.1	0.7
DEPTH, (H-L)	0.2		0.2		0.2		0.2		0.1		0.1	
DEPTH(H/L)	4.4		3.0		5.4		4.1		3.1		2.9	
WIDTH/DEPTH RATIO	20.2		15.3		24.4		16.3		14.7		11.6	
SUBSTRATE LENGTH (cm)	21.3	1.5	13.9	1.6	4.7	3.0	9.7	1.7	10.9	1.5	13.1	1.3
ALKALINITY (mg/l CaCO3)	76		82		74.0		86		49		80.0	
HARDNESS (mg/l CaCO3)	100		78		67.0		110		51		76.0	
pH	8.3		8.5		8.2		8.1		8.4		8.2	
SPECIFIC CONDUCTANCE (umhos/cm @25 C)	129		168		142.0		139		153		151.0	
ANNUAL TEMP RANGE (C)	13		13		12		13		10		12	
CHLOROPHYLL (mg/m2)	1.3	0.5	4.6	0.8	5.2	0.4	8.7	0.8	0.4	1.4	4.7	0.7
CHL. AFDM (g/m2)	2.2	0.5	2.7	0.5	0.4	0.4	4.0	0.4	0.7	0.5	0.5	0.4
B/C (AFDM/CHLOROPHYLL)	1669		573		80		462		174		95	
BOM (g/m2)	45.6	0.75	113.8	0.49	222.3	0.79	178.9	0.82	197.1	0.35	121.5	0.72

decreases in alkalinity and total hardness from 1990 to 1992. Delta-T (water temperature) was unchanged among years for each site.

Periphytic and Benthic Organic Matter: Algal chlorophyll a values increased in Goat Creek, remained unchanged in Dunce and Cougar Creeks, and decreased in Cliff Creek in 1992 (Fig. 8). Algal biomass (as AFDM) was low at all sites for 1992. The quantity of BOM was unchanged in all sites for 1992 except for Dunce Creek which showed an increase from 1991 to 1992. The percent charcoal of BOM also was similar between 1991 for 1992 for all sites except Goat where the mean %charcoal of BOM increased from about 30% in 1991 to about 50% in 1992 (Fig. 8).

Benthic Macroinvertebrates: The density of macroinvertebrates increased about 2X at all sites in 1992 from 1991; being especially evident at Goat, Dunce and Cougar Creeks (Fig. 9). Average biomass showed trends similar as macroinvertebrate numbers. The mean species richness increased in Dunce and Cougar Creeks in 1992 over 1991 values, while remaining unchanged in Goat and Cliff Creeks for this same time period.

Simpson's dominance increased in all sites in 1992 from 1991 values except for Cliff Creek (Fig. 10). However, dominance values were still relatively low, being less than 0.30 in Goat and Dunce Creeks. Similarily, Shannon's diversity decreased in all sites except Cliff in 1992 from 1991 values.

Miners and scrapers were predominant in Cliff Creek from 1990 through 1992 (Table 9). Scrapers were most abundant in Cougar Creek in 1990, while miners became predominant in 1991 and 1992. Gatherers, predators, and shredders were predominant in 1990 in Dunce Creek, while filterers and miners became predominant in 1991 and 1992. Filterers were abundant in 1990 and 1991 in Goat Creek, whereas miners became predominant in 1991 and 1992.

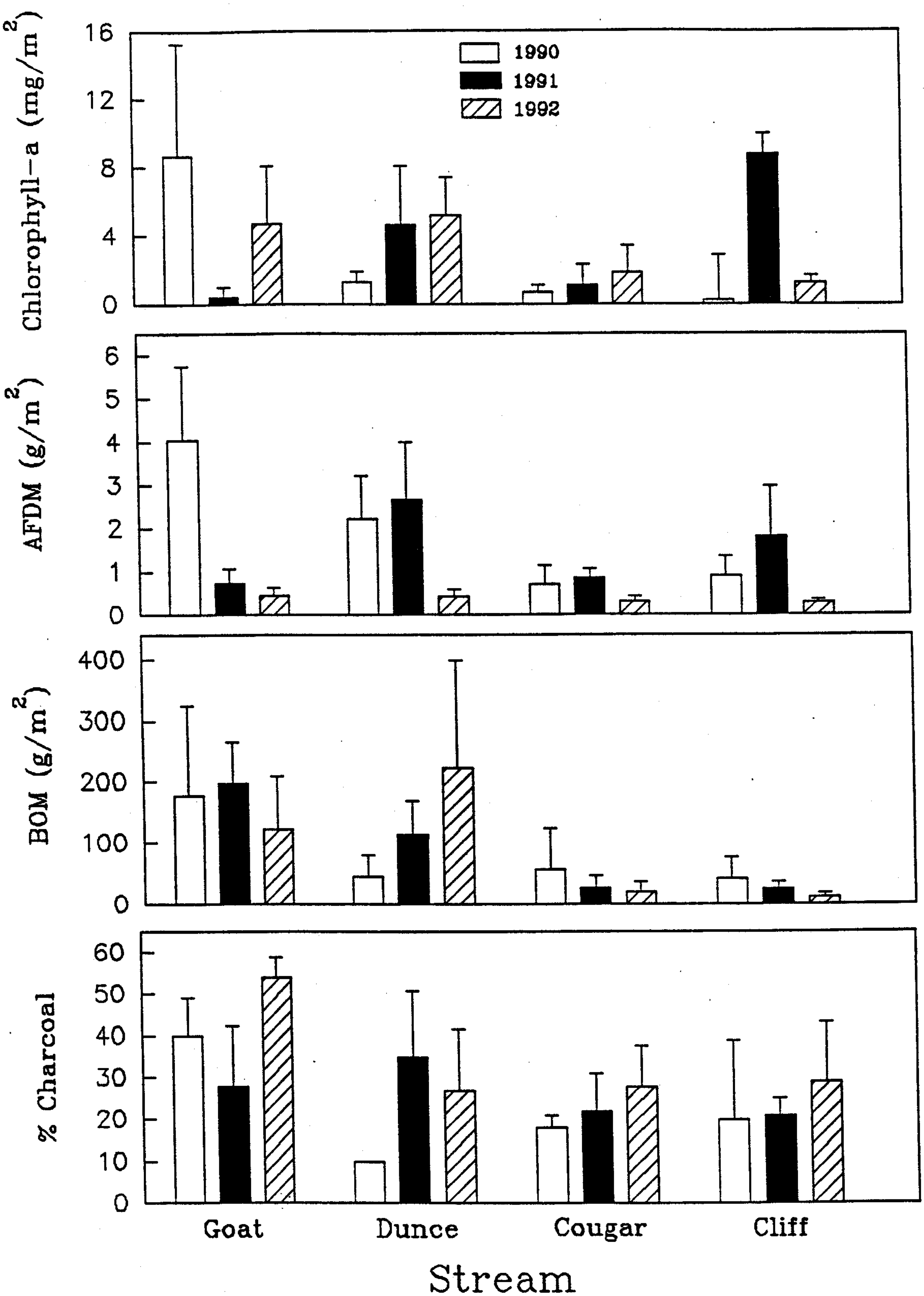

Figure 8. Periphyton chlorophyll-a, Ash-Free-Dry-Mass, Benthic Organic Matter (BOM), and percent charcoal of BOM for four burn streams sampled in 1990, 1991, and 1992. Error bars equal one standard deviation from the mean (n=5).

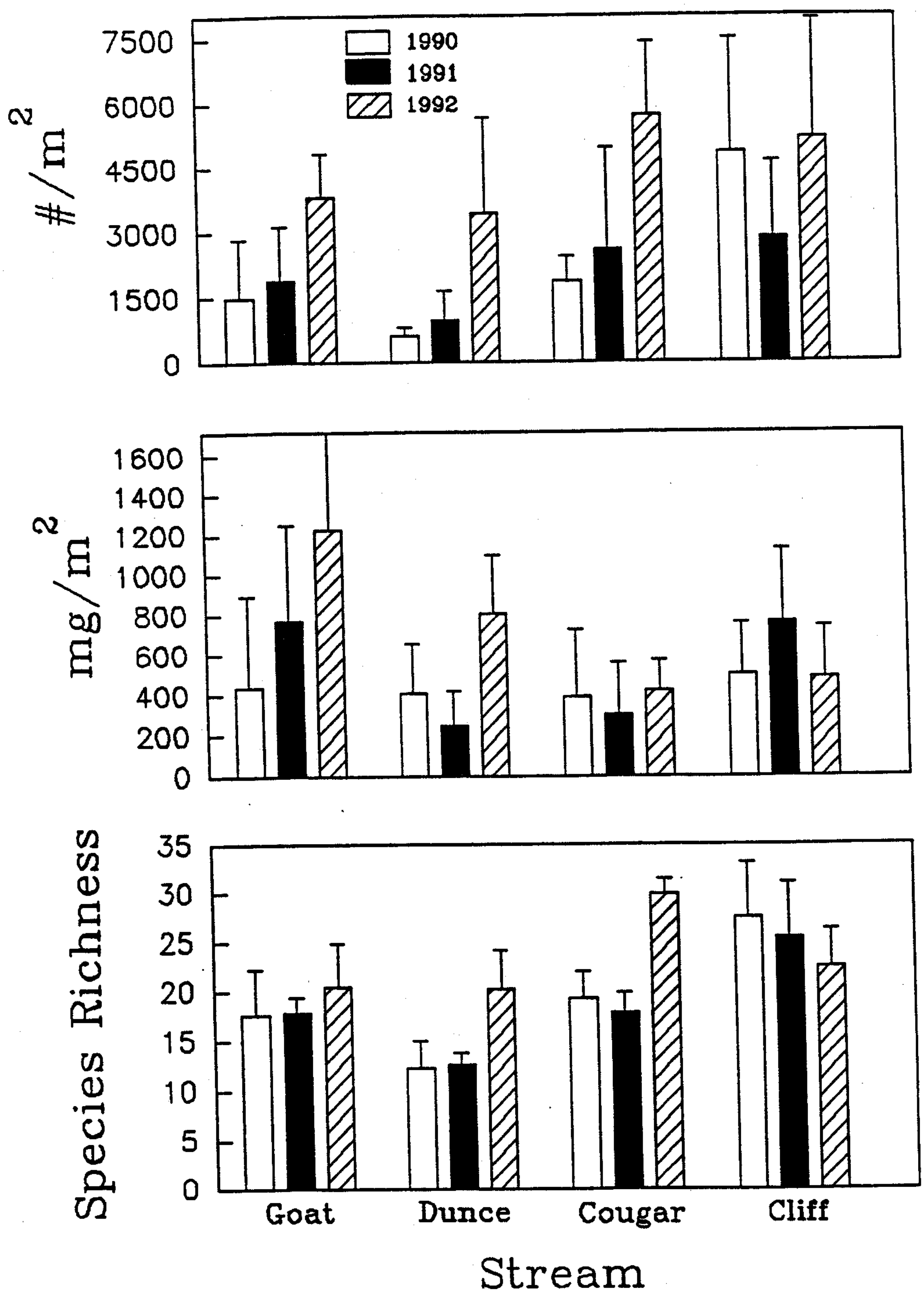

Figure 9. Mean macroinvertebrate density, biomass, and species richness collected in four burned streams in 1990, 1991, and 1992. Error bars represent one standard deviation from the mean (n=5).

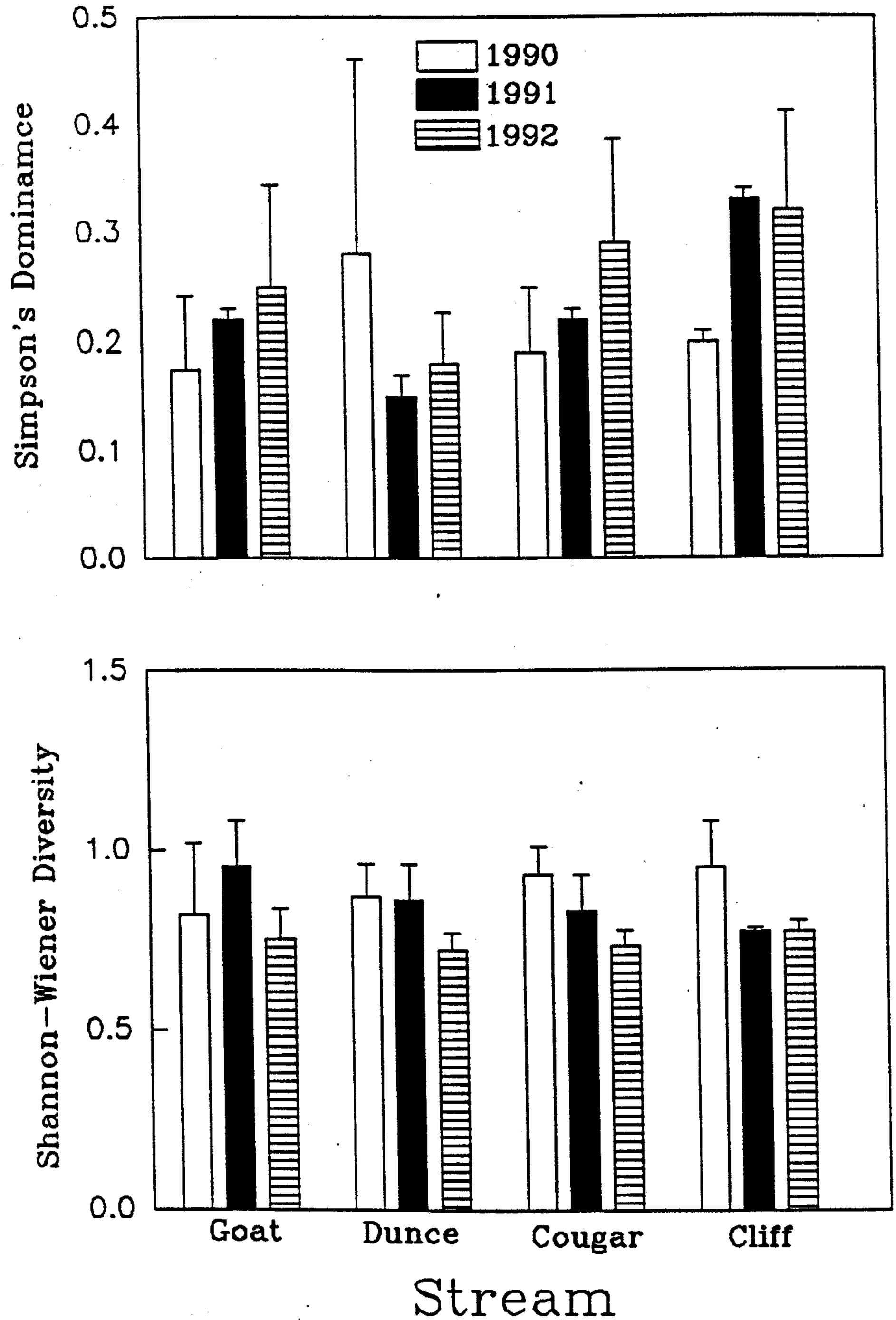

Figure 10. Macroinvertebrate Simpson's Dominance and Shannon–Weiner Diversity for four burned streams sampled in 1990, 1991, and 1992. Error bars represent one standard deviation from the mean (n=5).

Table 9. Mean and relative abundance (#/m2) and biomass (mg/m2) of macroinvertebrate functional feeding groups for Cliff, Cougar, Dunce, and Goat Creeks in 1990, 1991 and 1992.

	CLIFF						COUGAR						DUNCE						GOAT					
	1990		1991		1992		1990		1991		1992		1990		1991		1992		1990		1991		1992	
FFG	Mean	Rel. %	Mean	Rel. %	Mean	Rel. %	Mean	Rel. %	Mean	Rel. %	Mean	Rel. %	Mean	Rel. %	Mean	Rel. %	Mean	Rel. %	Mean	Rel. %	Mean	Rel. %	Mean	Rel. %
ABUNDANCE																								
Predator	667.9	14.1	224.1	12.7	148.4	3.2	224.1	12.7	147.3	5.7	339.8	6.5	125.9	21.1	153.9	15.9	350.5	12.4	288.1	16.2	254	14.6	234.4	7.9
Gatherer	761.8	14.5	275.3	15.6	630.1	10.8	629.5	32.9	264.6	10.3	913.9	15.8	157.9	27.0	145.1	15.0	356.9	12.8	384.1	24.1	91.8	5.3	819.3	22.8
Scraper	1195.1	29.1	384.1	21.7	412.9	25.1	486.6	25.2	646.6	25.1	197.8	18.6	25.6	4.5	59.8	6.1	137.6	14.6	66.1	4.8	119.5	6.8	38.7	10.2
Shredder	138.7	2.4	47.0	2.7	215.1	3.3	79.0	4.0	106.7	4.1	331.2	7.1	136.6	22.0	57.6	5.9	126.8	2.7	132.3	8.0	25.6	1.5	144.1	5.0
Filterer	337.2	8.3	100.3	5.7	131.2	2.8	79.0	5.2	277.4	10.7	178.5	3.2	19.1	7.2	292.4	30.2	1021.4	23.9	571.9	26.7	373.5	21.4	81.7	2.7
Miner	1720.0	30.5	736.2	41.7	2754.7	54.9	326.5	18.5	1139.6	44.2	2989.1	48.9	89.6	17.4	260.4	26.9	1064.5	33.7	292.4	17.8	881.3	50.5	2115.9	51.5
BIOMASS																								
Predator	88.7	15.1	83.2	12.7	31.9	6.6	41.3	17.0	69.1	22.8	140.1	33.4	6.9	3.9	46.1	18.7	133.5	16.6	27.2	5.1	107.9	17.6	137.6	11.2
Gatherer	162.8	24.2	102.2	15.6	62.7	13.0	75.4	31.2	22.2	7.3	60.1	14.3	147.1	34.4	25.9	10.5	103.8	12.9	108.0	28.7	24.9	4.1	146.1	11.9
Scraper	182.5	28.3	142.6	21.8	230.8	47.7	53.9	16.3	127.0	41.8	99.3	23.7	2.1	1.5	40.8	16.5	26.9	3.3	2.9	1.4	19.2	3.1	38.3	3.1
Shredder	10.4	1.9	17.4	2.7	5.4	1.1	25.9	5.9	10.8	3.6	16.1	3.8	41.7	7.9	55.9	22.7	144.7	17.9	58.0	16.8	3.7	0.6	20.1	1.6
Filterer	111.9	14.8	37.2	5.7	81.2	16.8	112.1	13.0	31.5	10.4	61.8	14.7	8.5	6.0	22.1	9.0	39.2	4.9	31.6	11.3	33.9	5.5	10.4	0.8
Miner	58.3	8.8	273.3	41.7	33.8	14.0	8.8	5.1	43.0	14.2	41.7	9.9	197.8	45.5	56.0	22.7	199.7	24.8	198.1	32.5	425.2	69.2	878.9	71.4

Gatherers were abundant in Goat Creek in 1990 and 1992, decreasing in abundance in 1991.

The most common taxa observed in Cliff Creek consisted of the Oligochaeta, *Heterlimnius, Baetis,* and Chironomidae (Table 10), although some *Simuliidae* were present in all sample years. *Baetis, Heterlimnius,* Chironomidae, and the Oligochaeta were most common in Cougar Creek. The shredder *Zapada* was most common in Dunce Creek followed by Oligochaeta and Chironomidae. Ostracoda and *Heterlimnius* were common in Goat Creek in 1990, while the Oligochaeta and Chironomidae became more common in 1991 and 1992.

Interbasin Comparison

In this section we present preliminary analyses examining abiotic and biotic differences among Big Creek Basin streams and Chamberlain Basin streams. We also included data on streams 5th and 6th order in size that drain into the Middle Fork of Salmon River in order to compare streams over a broader range of sizes. Multivariate analyses (Principal Components and Multiple Discriminant Analyses) were used to determine among basin and stream size differences. Abiotic factors considered are found in Table 2. Biotic factors considered were community level indices of macronvertebrate density, biomass, species richness, diversity, dominance, and functional feeding groups. Streams used for analysis, and respective basin category are found under objective 4 in Table 3. We also included a habitat evaluation for five streams in Big Creek Basin and three streams from Chamberlain Basin.

Habitat assessment scores for streams of both basins show relatively good aquatic and riparian habitat conditions (Table 11). For example, all sites scored at least 80% of the maximum score possible. However, the data indicate that streams of

Table 10. Means, standard deviations (SD), and relative percentages (%) of the densities (#/m2) of the 10 most abundant invertebrate taxa collected at Cliff, Cougar, Dunce and Goat Creeks in 1990, 1991, and 1992.

TAXA	CLIFF 1990 Mean	CLIFF 1990 SD	CLIFF 1990 %	CLIFF 1991 Mean	CLIFF 1991 SD	CLIFF 1991 %	CLIFF 1992 Mean	CLIFF 1992 SD	CLIFF 1992 %	COUGAR 1990 Mean	COUGAR 1990 SD	COUGAR 1990 %	COUGAR 1991 Mean	COUGAR 1991 SD	COUGAR 1991 %	COUGAR 1992 Mean	COUGAR 1992 SD	COUGAR 1992 %
Amphinimura sp.																		
Baetis sp.	864	1030	18	225	148	8	849	337	17	316	152	17	555	409	20	737	388	13
Ceratopogonidae													85	84	1			
Chironomidae	1001	1383	21	143	52	5	161	92	3	245	149	13	275	320	10	286	147	5
Cinygmula sp.	203	249	4	86	78	3												
Doliphilodes							333	577	6									
Drunella doddsi				36	17	1	218	160	4									
Ephemerella tibalis				33	41	1												
Epeorus sp.							118	108	2				64	60	1			
Heptageniidae										85	116	5						
Hetelimnius sp.	672	370	14	226	160	8	376	214	7	593	383	32	226	178	10	746	407	13
Hexatoma sp.										49	49	3	53	45	1			
Hydracarina sp.																114	70	2
Lepidostoma																156	145	3
Lumbriculidae																		
Micrasema sp.																118	0	2
Narpus sp.																		
Neophylax sp.							118	97	2	49	49	3						
Neothrema																		
Nematoda																		
Oligochaeta	706	769	15	1707	1327	59	2593	1345	50	70	51	4	864	776	30	2703	1423	48
Optioservus																		
Ostracoda	151	46	3							51	37	3				97	84	2
Simuliidae	156	195	3	89	46	3	143	79	3				341	570	10			
Suwallia sp.	327	350	7	90	79	3				73	23	4	64	11	1			
Turbellaria sp.																		
Yoroperla brevis																		
Zapada sp.				34	15	1	344	390	6	64	66	4	53	61	1	402	156	7
TOTAL %			84			93			100			86			85			95

Table 10 (con't)

TAXA	DUNCE 1990 Mean	DUNCE 1990 SD	DUNCE 1990 %	DUNCE 1991 Mean	DUNCE 1991 SD	DUNCE 1991 %	DUNCE 1992 Mean	DUNCE 1992 SD	DUNCE 1992 %	GOAT 1990 Mean	GOAT 1990 SD	GOAT 1990 %	GOAT 1991 Mean	GOAT 1991 SD	GOAT 1991 %	GOAT 1992 Mean	GOAT 1992 SD	GOAT 1992 %
Amphinimura spp.																167	119	4
Baetis spp.	19	21	3				376	339	11	45	67	3	109	95	6	340	301	9
Ceratopogonidae	73	145	12							56	118	3						
Chironomidae	47	44	8	87	100	9	351	266	10	143	137	8	373	282	19	402	272	11
Cinygmula sp.																		
Doliphilodes																		
Drunella doddsi																		
Ephemerella tibalis													60	74	3	376	226	10
Epeorus sp.																		
Heptageniidae																		
Hetelimnius sp.	68	85	12	128	138	13				303	281	17	128	234	7	361	152	10
Hexatoma sp.																		
Hydracarina sp.				19	43	2	134	38	4	49	39	3	41	32	2			
Lepidostoma																		
Lumbriculidae							118	65	3									
Micrasema sp.																		
Narpus sp.	58	102	10	58	82	6												
Neophylax sp.																		
Neothrema							167	120	5									
Nematoda				68	153	7	140	86	4									
Oligochaeta	43	27	7	173	170	18	714	814	21	92	52	5	583	393	32	1714	872	45
Optioservus							328	166	9									
Ostracoda							201	151	6	463	426	26	109	243	6	61	22	2
Simuliidae	24	21	4	85	50	9				107	193	6	265	322	13			
Suwallia sp.	36	25	6	38	47	4				77	72	4	120	136	6	54	0	1
Turbellaria sp.													60	46	3	190	56	5
Yoroperla brevis	79	289	13	30	35	3												
Zapada sp.	58	100	10	179	243	19	973	1035	27	90	79	5				70	48	2
TOTAL %			85			90			100			81			97			95

Table 11. Habitat assessment scores for respective field sites of Big Creek and Chamberlain Basins.

HABITAT MEASURE	SUBSTRATE COVER	EMBEDDEDNESS	FLOW TYPES	CANOPY COVER	CHANNEL ALTERATION	DEPOSITION	POOL/RIFFLE RATIO	WIDTH/DEPTH RATIO	BANK STABILITY	BANK VEGETATION	RIPARIAN COVER	RIPARIAN WIDTH	TOTAL SCORE	PERCENT OF MAXIMUM
Big Creek Basin: maximum total score = 135.														
Goat	16	18	15	na	15	14	12	na	10	10	10	na	120	89
Dunce	18	14	9	na	13	14	11	na	10	10	9	na	108	80
Cougar	20	18	15	na	14	14	11	na	8	9	10	na	119	88
Cliff	18	20	17	na	15	15	12	na	10	10	10	na	127	94
Rush	15	20	8	na	15	10	8	na	9	10	10	na	105	78
Chamberlain Basin: maximum total score = 180.														
Phantom	18	11	5	17	20	15	14	15	10	10	9	10	154	86
West Fork Chamberlain	12	15	18	11	15	7	15	13	10	10	7	10	143	79
Chamberlain	20	20	17	16	15	15	12	15	10	9	9	8	166	92

Chamberlain basin scored higher in the pool/riffle category, which supports the observation that streams in Chamberlain are of lower gradient than streams in Big Creek basin.

Figure 11 represents the results from the PCA. The data show that streams separate by stream size along Axis-1, with larger streams having greater Delta-T, larger substrata, and lower gradients than small streams. Axis-2 suggests that smaller streams exhibit greater variation in channel characteristics, algal resources, and elevation than larger streams.

The multiple discriminant results clearly separated the smaller streams between basins, and the smaller streams from the larger ones based on habitat characteristics (Fig. 12). Abiotic factors important in the analysis included chemical measures (specific conductance), water velocities, substrate, and algal resources. Although, further analysis is required before determining clear patterns in habitat characteristics among these basins and streams of different size, the data strongly suggest that a multiple variate approach is necessary (see also Boulton and Lake 1992).

The results of MDA using biotic components also clearly separated streams among basins and the larger streams from smaller streams of these basins (Fig. 13). Here, the biotic factors that were important included diversity, dominance, richness, density, %shredders, %predators, and %scrapers. The results clearly indicate that habitat differences exist among these basins and among streams of different size and suggest that these habitat differences may be translated into differences in biotic properties of the basins and streams. Further analyses will refine the multivariate approaches already used and include additional analyses relating environmental differences with associated biotic differences, e.g., Canonical Correspondence Analysis, and also analyses at the taxonomic level.

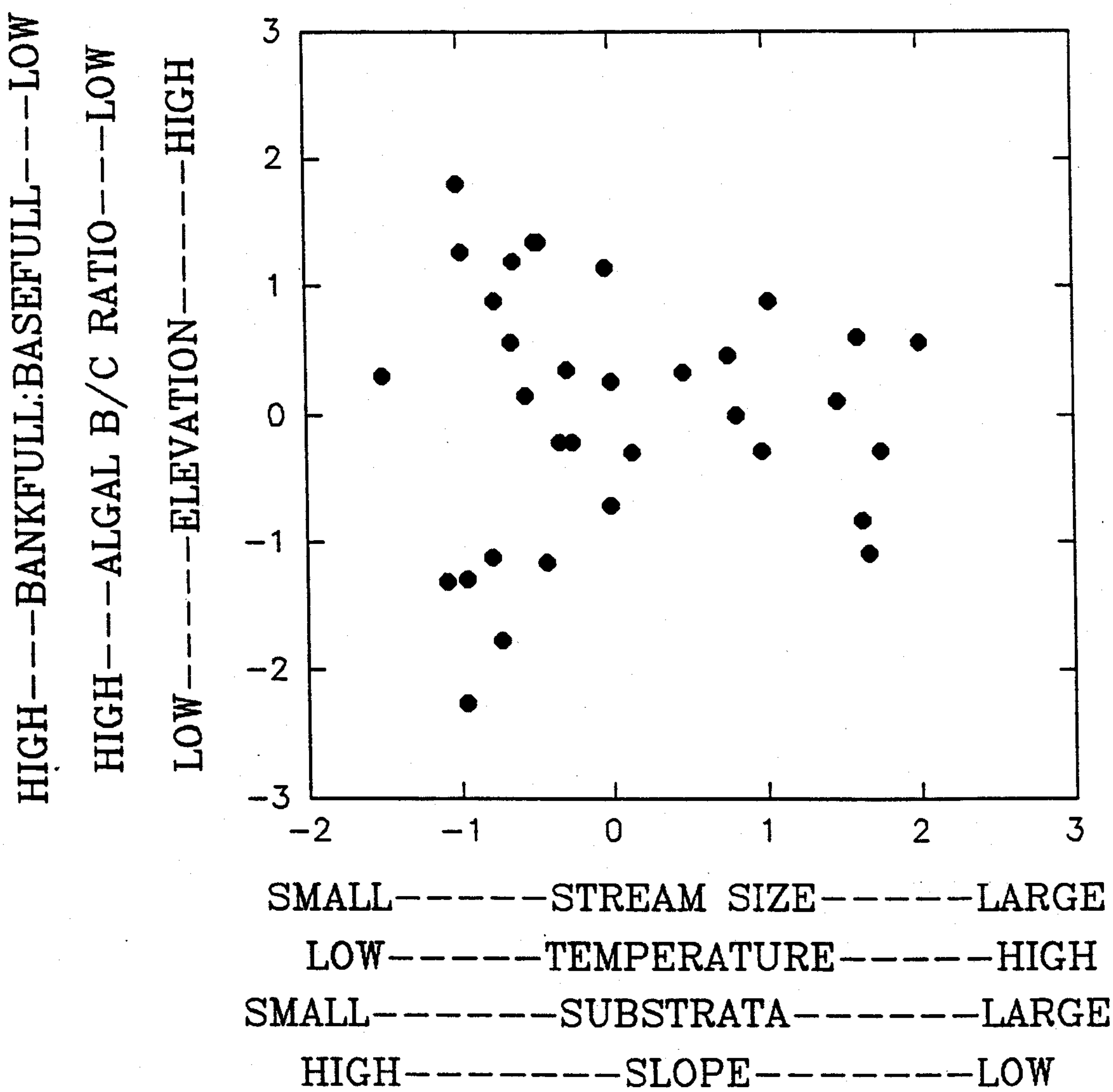

Figure 11. Results of principal components analysis indicating important habitat measures used to separate individual streams. See text for explanation.

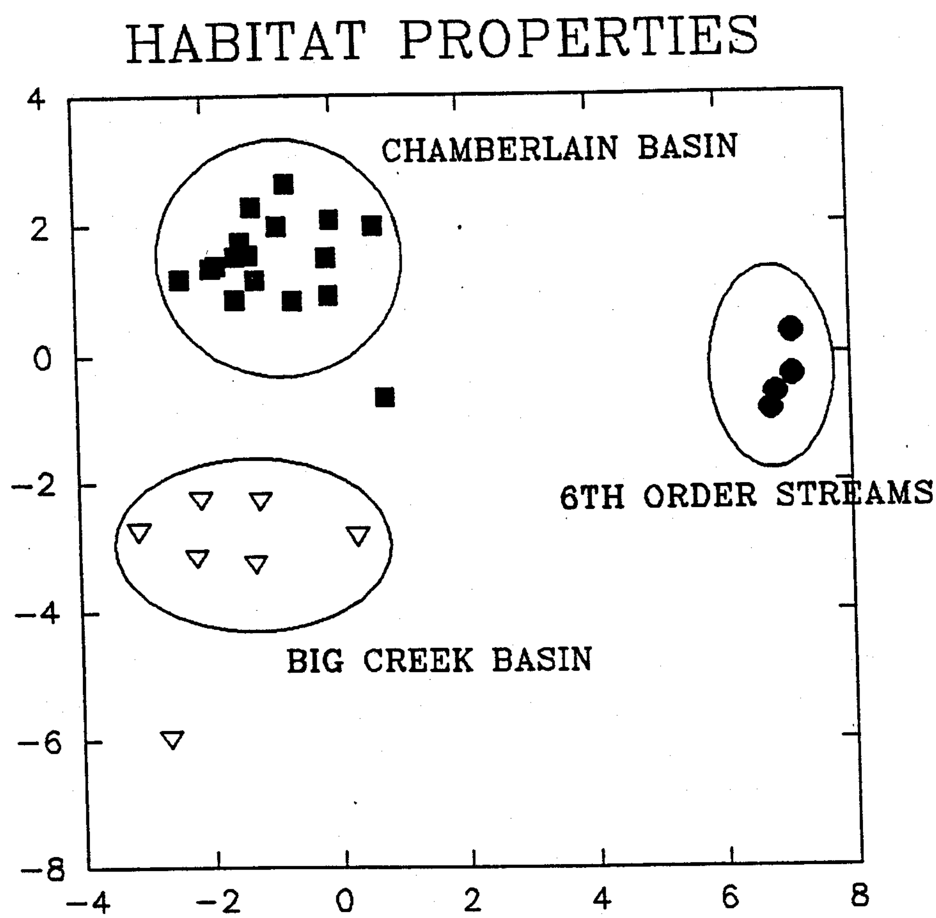

Figure 12. Results of multiple discriminant analysis used to separate streams by basin based on difference in habitat properties. See text for explanation.

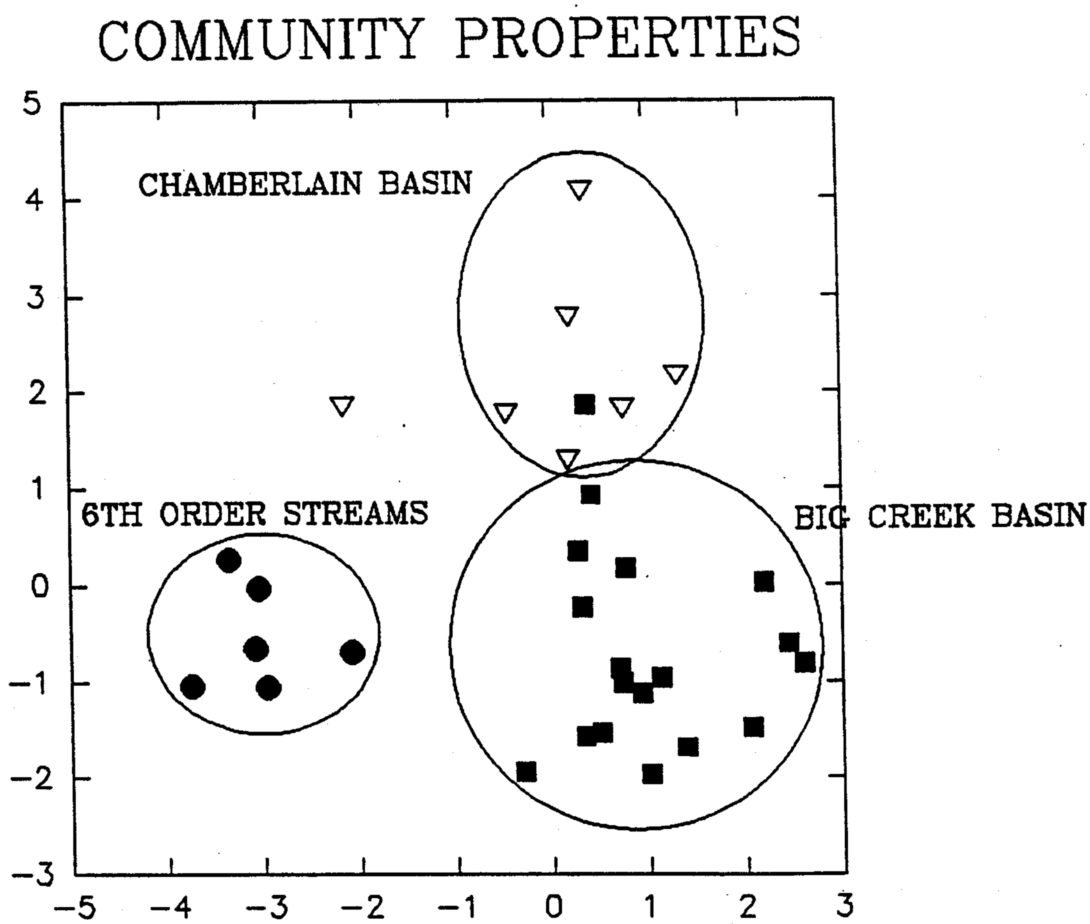

Figure 13. Results of multiple discriminant analysis used to separate streams by basin based on community properties of macroinvertebrate assemblages. See text for explanation.

DISCUSSION/SUMMARY

Cliff Creek showed little change in 1992 from 1991 in either abiotic or biotic measures. The BOM data suggest that burned organic matter is still entering from upstream sources. The macroinvertebrate community in Cliff Creek in 1991 and 1992 was prediminantly miners, in particular the Oligochaeta. The scraper *Baetis* sp. also displayed high abundances. Both miners and *Baetis* are commonly associated with some form of disturbance in streams. Thus far, however, Cliff Creek has displayed minimal physical effects from the 1988 wildfires, but the increase in burned organic matter in the BOM suggests delayed and continued influences from upstream events. The increase in substrate CV's over time further suggest subtle physical changes in substrate characteristics such as an increase in fine sediments from upstream sources. Cliff Creek provides the unique opportunity to examine the short- and long-term influence, i.e., delayed impacts, of burned headwaters on downstream reaches.

Since 1988, Rush and Pioneer Creeks have been sampled and examined in various years. These streams are adjacent watersheds draining similar aspect, but differing in size. These two watersheds provide the opportunity to examine long-term spatial variability in two streams of different size in the same geographic area. The data thus far suggest that Rush Creek exhibits greater temporal variability in abiotic properties, such as annual temperature range, than Pioneer Creek. This agrees with the River Continuum Concept and our recent presentation at 1993 annual meeting of the North American Benthological Society held in Calgary, Alberta, Canada.

The 1992 data also showed minimal additional effects of the 1988 Wildfires on Goat, Dunce, Cougar, and Cliff Creeks. Results obtained from this summers sampling (1993) will allow us to contrast a series of drought years with wetter (more "normal") conditions. We anticipate that substantial abiotic and biotic differences will be found. These streams have experienced little change in channel characteristics that we have observed in studies of the Mortar Creek Fire (1979) and the Yellowstone Fires (1988) as a result of the either the degree and intensity of the Golden Fire or the climatic differences among these various geographic areas. The arid environment of Big Creek, particularly over the past few years, seems to have minimized extreme runoff events observed in streams impacted by the Mortar Creek and Yellowstone National Park fires.

Multivariate analyses provide a promising avenue for determining habitat and biotic differences among drainage basins and streams of different size. The present analyses are preliminary in nature, but touch upon the possible patterns discerned from using such analyses. We intend to expand and refine these analyses during the next year to more clearly depict differences among the Big Creek basin streams and Chamberlain basin streams. We believe outcome will be quite enlightening and fruitful for resource managers.

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